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A COMPARISON OF THE TECHNICAL COMMUNICATIONS PRACTICES OF JAPANESE AND U.S. AEROSPACE ENGINEERS AND SCIENTISTS

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Abstract

To understand the diffusion of aerospace knowledge, it is necessary to understand the communications practices and the information-seeking behaviors of those involved in the production, transfer, and use of aerospace knowledge at the individual, organizational, national, and international levels. In this paper, we report selected results from a survey of Japanese and U.S. aerospace engineers and scientists that focused on communications practices and information-seeking behaviors in the workplace. Data are presented for the following topics: importance of and time spent communicating information, collaborative writing, need for an undergraduate course in technical communications, use of libraries, the use and importance of electronic (computer) networks, and the use and importance of foreign and domestically produced technical reports. The responses of the survey respondents are placed within the context of the Japanese culture. We assume that differences in Japanese and U.S. cultures influence the communications practices and information-seeking behaviors of Japanese and U.S. aerospace engineers and scientists.

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Introduction

Communicating with people with whom one does not share the same culture and native language creates significant challenges in a technical environment. Nowhere is this more apparent than between Japan and the U.S., two major industrialized nations that are engaged in a number of collaborative as well as competitive business ventures in high technology fields. Perry notes that "when East meets West, the biggest abnormality is in communications," and he attributes most communication problems to differences in culture and language (1990, p. 53). Although expanding telecommunications networks are rapidly bridging geographic distances, cultural differences among nations that are involved in collaborative business ventures may actually be contributing to a "new era of cultural confrontations and value conflicts" (Koizumi, 1990, p. 220).

The aerospace industry provides an excellent platform for investigating the impact of cultural differences on technical communication, for Japanese and U.S. manufacturers have enjoyed collaborative relationships since the end of World War II. After the Japanese aircraft industry was destroyed by the U.S. occupation forces, it gradually rebuilt itself by producing U.S. military aircraft (F-86s and F-15s) under the Japanese/U.S. Mutual Defense Assistance Agreement.

During the 1960s and early 1970s, Japanese firms were subcontractors for major U.S. commercial aircraft firms, but by the 1980s, the Japanese producers had begun to play an active role in all phases of the production and sales of the new aircraft (Mowery & Rosenberg, 1985, pp. 74-76). Japan and the United States continue to participate as active members of multinational collaborative efforts in the aerospace industry, and joint ventures between Japan and the United States are expected to flourish in commercial aerospace engineering throughout the 1990s. Through such collaborative projects, the Japanese aircraft industry is expected to transform itself from a supporting player with the West to a true joint venture member contributing its own talent (Mowery & Rosenberg, 1985, p. 79). However, much of the success or failure of these collaborative projects may depend on the ability of the individual participants to communicate effectively and to identify and bridge the communication gaps created by cultural differences.

Background

We conducted a mail (self-reported) survey of Japanese and U.S. aerospace engineers and scientists to determine the importance of and time spent communicating technical information, collaborative writing, an undergraduate course in technical communications, use of libraries, the use and importance of electronic (computer) networks, and the use and importance of foreign and domestically produced technical reports.

This research was conducted as a Phase 4 activity of the *NASA/DoD Aerospace Knowledge Diffusion Research Project* (Pinelli, Kennedy, & Barclay, 1991). Phase 4 of the project focuses on knowledge diffusion at the international level and is concerned with the impact of cultural and linguistic differences on workplace communication. The findings from the Japanese/U.S. study may increase our understanding of Japanese culture and may contribute to improving the effectiveness of cross cultural communication among aerospace engineers and scientists involved in multinational collaborative projects. In this paper, we explore a number of cultural factors that play a significant role in Japanese technical communication, present data from our survey of Japanese and U.S. aerospace engineers and scientists, and offer some thoughts on improving the ability of Japanese and U.S. aerospace engineers to communicate successfully while working collaboratively.

Cultural Factors Affecting Communications and Information-Seeking

A number of researchers have investigated cultural factors affecting communication between Japan and the U.S. (Ford & Honeycutt, 1992; Goldman, 1994; Kato & Kato, 1992; Maher & Wong, 1994; McNamara & Hayashi, 1994; and Ohsumi, 1995). In this section, we consider the importance of group think vs. individual expression, differences in high-context and low-context communications, attitudes about contractual agreements, the influence of religion on Japanese culture, "mental telepathy" and "apparent" vs. "real" messages as communications norms, and the Japanese preference for informal (oral) communications over formal written communications. Although the following analysis provides useful insights into understanding how cultural differences affect communication, the analysis is not exhaustive. An analysis of linguistic differences is also missing from this discussion. For readers who may be interested in the linguistic aspects of a cross cultural comparison of Japanese and U.S. communications, we recommend an article written by Kohl et al. (1993), "The Impact of Language and Culture on Technical Communication in Japan."

Group Think vs. Individual Expression

The most striking feature of what makes the Japanese communication unique in the eyes of the Westerners is the concept of group think based on hierarchy. Ford & Honeycutt (1992) trace the existence of a hierarchical structure to Confucianism that was brought from China to Japan during the fifth century. Confucianism teaches that "the need for submission to elders and those of superior position in the group" is a prerequisite of a society (Ford & Honeycutt, 1992, p. 31). Such group think is an extension of the holism in society that provides a basis for corporate decision making (McNamara & Hayashi, 1994, p. 7).

Individualism, which is cherished in the West, is not considered a virtue in Japanese society. The Japanese expression, "the nail that stands up will be pounded down," exemplifies the clear distaste for individualism that most Westerners note as one of the distinct features of Japanese unwritten codes (Maher & Wong, 1994, p. 43; Buckett, 1991, p. 88) In considering the role of the individual in society, Nakane (1972) asserts that an individual is defined by an attribute that makes up a frame. A group or a frame is formed when individuals share common attributes (Nakane, 1972, p. 7). Thus, the individual has meaning only within the context of a group. The notion of collectivism is ubiquitous from private to public, from family to corporate organizations, and from local to national levels. The emphasis on harmony among individuals in groups mirrors "the communal ethic of Shinto" (Maher & Wong, 1994, p. 43); it is assumed that the homogeneous nature of Japanese society makes it possible to carry out group think.

High Context/Low Context Communication

A second feature to consider in comparing Japanese and U.S. cultural differences is the idea of high or low context communication. Hall & Hall (1987) define high and low context as:

> A high context (HC) communication is one in which most of the information is already in the person, while very little is in the coded, explicit, transmitted part of the message. A low context (LC) communication is just the opposite; i.e., the mass of the information is vested in the explicit code (p. 8).

Japan has enjoyed the advantage of never having been invaded by another nation. Thus, a homogeneous and isolated Japanese society could afford to foster HC communication in which almost everyone understands the beliefs, principals, and assumptions about how to go about interacting with people (McNamara & Hayashi, 1994, p. 10).

On the other hand, the United States is a heterogeneous, LC society in which a melting pot approach to communication is the norm. In a society whose citizens have diverse national and ethnic backgrounds, it is inevitable that everything to be communicated to others has to be described explicitly. Assumptions also have to be explained because there is no single set of beliefs or rules of conduct governing society. Therefore, "explicit digital and verbal communication is an essential element in western, and especially American, culture" (McNamara & Hayashi, 1994, p. 10). It is noteworthy to mention that there is always a danger in classifying everything in dichotomous fashion. For instance, Inaba (1988) argues that Hall & Hall's (1987) classification of Japanese and U.S. citizens as HC and LC respectively may be shortsighted, for it excludes nonverbal behavior. However, the literature supports Hall & Hall's (1987) assertions about Japanese and U.S. communications norms, and it is beyond the scope of this paper to address nonverbal behavior.

Contractual Agreements

The concept of a contractual agreement is very foreign in Japan. Nakane (1972) states that "any sense of contract is completely lacking in the Japanese, and to hope for any change along the lines of a contractual relationship is almost useless" (p. 80). The influence of common law may provide the foundation of contractual agreements that are so important in the United States. Goldman (1994) suggests that it is so important for Japanese to acknowledge other people based on ningensei or "human beingness" that there is no room for logic or rules to be laid out (p. 235). Ohsumi (1995) also stresses the fact that U.S. society is based on rules, but Japanese society has low regard for rules. The preference of the Japanese to do without contracts and rules may be related to the cultural features of the group think and HC. In Japanese society, it is assumed that everyone communicates under the same preexisting set of beliefs; therefore, there is no need to spell out explicitly what is expected.

The Influence of Religion on Japanese Culture

In Japan, religious beliefs are assumed to be an integral part of an individual's history. Although Japanese society is experiencing a noticeable decline in religious affiliation, religious ritual, symbolism, and attitude continue to play an important role among the Japanese people (Maher & Wong, 1994). The Japanese are deeply influenced by ideas and concepts coming from animism, Buddhism, Confucianism, Shinto, Taoism, and Zen. Elements of Confucianism, Buddhism, and Shinto continue to affect the daily lives of the Japanese although the trend toward secularism noted recently in the West actually began almost three centuries ago in Japan (Reichauer & Jansen, 1995, p. 203). The strong work ethic and an emphasis on harmony come from Confucianism. Matsuda (1991) correlates the ideas of group actions, shared responsibility, harmony, and a strong loyalty to the group with Buddhism, the reason being that Buddhism teaches that everything in nature has life, and therefore one's life is a part of the nature (p. 106). Shinto has been the official national religion since the Meiji Restoration of 1868. Originating from Buddhism, Shinto evolved as a set of beliefs associated with the foundation myths of Japan and with the cult of imperial ancestors. Shinto focused attention within a Japan that was becoming more nationalistic and "eventually came to seek a new unity under symbolic imperial rule" (Reichauer & Jansen, 1995, p. 209).

Traditional Mental Telepathy: Ishin-denshin & Haragei

Japan as a homogeneous society has nurtured its people to communicate according to the principle of Ishin-denshin or "if it is in one heart, it will be transmitted to another heart" (Kato & Kato, 1992, p. x). In essence, a message should be conveyed to a receiver without using many words because both parties are capable of understanding each other wordlessly. Gudykunst and Nishida describe Inshin-denshin as "traditional mental telepathy" (1993, p. 150), for it assumes that a transmitted message will be understood by a receiver. Inshin-denshin is closely related to another Japanese concept called "haragei," literally meaning "belly language." Hara could be understood as "the center of abdominal respiration that is in charge of 'ki,' which is the mind and the body that acts almost like air that is inhaled and exhaled by a person" (Lebra, 1993, p. 65).

Surface/Bottomline Messages (Tatemae/Honne)

Human relationships in Japan have two sides, "tatemae" and "honne." "Tatemae is front face or what is presented and honne is true feelings privately held" (Hall & Hall, 1985, p. 61). "Honne is what a person really wants to do, and tatemae is his submission to moral obligation" (Gudykunst and Nishida, 1993, p. 152). The Japanese have two modes of communication; *tatemae* is a formal communication and *honne* is the language of the heart (Kato & Kato, 1992, p. 22). Tatemae usually is exchanged during business hours and honne surfaces outside office hours. The meanings of tatemae and honne are closely associated with what Ford & Honeycutt call "process or appearance vs. result or bottomline" (1992, p. 29). The same concepts can be thought of as "the apparent versus the real" (Maher & Wong, 1994, p. 44). The Japanese tend to place more importance on process than results (Ford & Honeycutt, 1992, p. 29). Thus, such seemingly meaningless rituals as an exchange of business cards and conversations without much essence in tatemae mode can be viewed as a way of showing respect for each other.

Emphasis on Informal Communication

The literature establishes that the Japanese rely heavily on informal communication (Kato & Kato, 1992). Personal contact or "knowing who" is extremely important. Of course, informal communication is very important in the U.S., but for the Japanese informal communication has some peculiar features. For instance, there exists "the old boys' network with links to practically every board room and laboratory in Japan" (Cutler, 1989, p. 22). This network is based on alumni networks of major colleges and universities that actually connect academia, government and industry. Kokubo notes that "researchers make courtesy calls on university professors, who serve as middlemen to relay information to their networks of alumni" (1992, p. 34). In addition to relying on colleges and universities, people extend their networking through other various "people links," for example, professional societies, consulting, collaborative work, and conferences (Cutler, 1989, p. 20).

It is interesting to note that information gathering through informal contacts is central to the idea of Japanese competitive intelligence. According to Kokubo, "competitive intelligence consists of (a) technical information gathering, (b) distribution of the acquired information to the right people, and (c) analytical work for decision-making" (1992, p. 35). In business, each project is led by a champion who works with staff members in the technology information office and patent department, senior researchers, and well-trained librarians. Managers are expected to gather and to disseminate the latest information through the company grapevine, industry-wide conferences, Zaibatsu groups or clubs, or business societies (Kokubo, 1992).

Methods and Sample Demographics

Mail (self-reported) Japanese-language questionnaires were sent to 13 Japanese aerospace engineers and scientists in academia and industry (in Japan) who have collaborated with the project team in other Phase 4 activities and understood the objectives of the study. We asked our colleagues to identify appropriate subjects to complete the questionnaires. A total of 94 surveys was completed during March-June 1994. We used the 340 surveys completed in 1992 by U.S. aerospace engineers and scientists at the NASA Ames and Langley Research Centers as our baseline for comparison with all Phase 4 survey data. For the complete methodology and results of the Japanese/U.S. study, see Pinelli, Barclay, and Kennedy (1994).

A t-test (for interval data) was used to estimate if the observed differences between Japanese and U.S. aerospace engineers and scientists are statistically significant. A significant test result ($p \leq .05$) indicates that there is only a 5% probability that the observed difference between the two responses can be attributed to chance. A significant result is therefore interpreted as evidence that a difference between the responses of the two groups of respondents on the factors or variables in question are influenced by (vary systematically with) cultural differences between the two groups.

Demographic Findings

The professional duties of the 94 Japanese aerospace engineers and scientists in this study are equally divided among design/development, research, and teaching/academic responsibilities. Most work in academia or government and very few work in industry. All of their U.S. counterparts work in government and most perform research duties. The Japanese respondents reported an average of 15 years of professional work experience, and the U.S. respondents reported an average of 17 years of professional work experience.

In terms of education, 45% of the Japanese respondents held master's degrees and 32% held doctorates; 95% of them were educated as engineers and 100% perform engineering duties. Among the U.S. respondents, 46% held master's degrees and 27% held doctorates; 80% were educated as engineers and 17% as scientists. In terms of their current duties, 69% of the U.S. respondents performed engineering duties and 27% performed science duties. Eighty-nine percent of the Japanese respondents reported membership in a professional/technical society, and 78% of the U.S. respondents were members of a professional/technical society. Because personal contacts are very important for the Japanese, it is reasonable to speculate that Japanese join such professional/technical societies to get to know the right people, to exchange information, and ultimately to work on projects jointly.

Language Fluency

Japanese respondents reported proficiency in reading and speaking English whereas the U.S. respondents reported little proficiency in reading and speaking Japanese (Table 1). The study of the English language is compulsory in Japan beginning in the seventh grade, and proficiency in a third language is compulsory in colleges and universities in Japan, giving the Japanese "a major linguistic advantage over their U.S. counterparts" (Grayson, 1984, p. 216). German was the third most popular third language among the Japanese respondents. The preference for German as a third language may be attributed to the fact that German systems influenced the modernization of Japan during and after the Meiji Restoration. The Japanese Constitution, parliament, and judicial systems that were created closely resembled those of German system during the Bismarck era (Sansom, 1950). Among the U.S. engineers and scientists, 5% reported proficiency in speaking Japanese and 3% reported proficiency in reading Japanese. French and German ranked second and third in terms of speaking (22%) (15%) and reading proficiency (32%) (21%) among the U.S. respondents.

Table 1. Language Fluency of Japanese and U.S. Aerospace Engineers and Scientists

Language	Read %	Speak %	$\bar{X}$ Ability[a]	
	Japan (n = 94)			
English	100	99	3.8	3.0
French	30	22	1.7	1.6
German	71	40	1.7	1.6
Japanese	100[b]	100[b]	—	—
Russian	18	10	1.3	1.6
	U.S. (n = 340)			
English	100[b]	100[b]	—	—
French	32	22	1.7	1.6
German	21	15	1.7	1.6
Japanese	3	5	1.7	1.7
Russian	6	5	1.6	1.5

[a]A 5 -point scale was used to measure ability with "1" being passably and "5" being fluently; hence, the higher the average (mean) the greater the ability of survey respondents to speak/read the language.

[b]This is the native language for these respondents.

Presentation of the Data

Data are presented for the following topics: importance of and time spent communicating technical information, collaborative writing, need for an undergraduate course in technical communications, use of libraries, the use and importance of electronic (computer) networks, and the use and importance of foreign and domestically produced technical reports.

Importance of and Time Spent Communicating Information

Japanese and U.S. aerospace engineers and scientists were asked a series of questions regarding (1) the importance of the ability to communicate technical information effectively, (2) change over the past five years in the amount of time spent communicating information, and (3) change in the amount of time spent communicating information as a function of professional (career) advancement. About 1% and 8% of the Japanese and U.S. respondents indicated that the ability to communicate information effectively was unimportant. About 95% and 91% of the Japanese and U.S. respondents reported that the ability to communicate information effectively was important. About 60% and 26% of the Japanese respondents indicated that over the past 5 years, the amount of time they spent communicating information had increased or had stayed the same. About 70% and 24% of the U.S. respondents reported that over the past 5 years the amount of time they spent communicating information had increased or had stayed the same. About 35% of the Japanese and about 65% of the U.S. respondents reported that as they have advanced professionally, the amount of time they spent communicating information had increased. About 34% of the Japanese and about 26% of the U.S. respondents indicated that the amount of time had stayed the same.

Survey respondents were asked to report the number of hours they spent each week producing (i.e., written and oral) and communicating information and the number of hours they spent each week working with information (i.e., writing and orally) received from others (Table 2). Data appearing in Table 2 indicate that the Japanese aerospace engineers and scientists in this study devoted significantly more hours each week than did their U.S. counterparts to preparing written communication. Conversely, U.S. respondents spent more hours each week communicating information orally than did their Japanese counterparts. Similarly, the U.S. respondents spent significantly more hours each week working with written communications received from others. Likewise, the U.S. respondents devoted significantly more hours receiving information orally from others than did their Japanese counterparts.

Table 2. Time Spent Each Week by Japanese and U.S. Aerospace Engineers and Scientists Communicating Information

	Japan	U.S.
	$\overline{X}$ hours	$\overline{X}$ hours
Time spent producing written materials	11.3 (Median 10.0)	8.3** (Median 6.0)
Time spent communicating information orally	4.6 (Median 4.0)	8.7** (Median8.0)
Time spent working with written information received from others	6.5 (Median 5.0)	7.7* (Median 5.0)
Time spent receiving information orally from others	3.5 (Median 2.0)	6.3* (Median 5.0)

*$p \leq .05$. **$p \leq .01$.

Collaborative Writing

The process of collaborative writing was examined as part of this study. Survey participants were asked whether they wrote alone or as part of a group (Table 3). Approximately 21% of the Japanese respondents and 15% of the U.S. respondents wrote alone. Although a higher percentage of the U.S. respondents than the Japanese respondents wrote with a group of 2 to 5 people or with a group of 5 or more people, writing appears to be a collaborative process for both groups.

Table 3. Collaborative Writing Practices of Japanese and U.S. Aerospace Engineers and Scientists

Collaborative Practices	$\overline{X}$ %	%*	(n)
	Japan		
I write alone	70.1	21	(20)
I write with one other person	12.8	57	(54)
I write with a group of two to five people	14.9	53	(50)
I write with a group five or more people	2.2	11	(10)
	U.S.		
I write alone	61.1	15	(50)
I write with one other person	20.7	72	(246)
I write with a group of two to five people	15.6	61	(208)
I write with a group five or more people	2.1	14	(47)

*Percentages do not total 100.

Japanese and U.S. aerospace engineers and scientists were asked to assess the influence of group participation on writing productivity (Table 4). Only 35% of the Japanese respondents and 32% of the U.S. respondents indicated that group writing is more productive than writing alone. Eighteen percent of the Japanese respondents and 32% of the U.S. respondents found that group writing is about as productive as writing alone, and 26% of the Japanese respondents and 20% of the U.S. respondents found that writing in a group is less productive than writing alone.

Table 4. Influence of Group Participation on the Writing Productivity of Japanese and U.S. Aerospace Engineers and Scientists

	Japan		U.S.	
Group Participation	%	(n)	%	(n)
A group is more productive than writing alone	35	(33)	32	(110)
A group is about as productive as writing alone	18	(17)	31	(107)
A group is less productive than writing alone	26	(24)	20	(68)
I only write alone	21	(20)	15	(50)

Of the respondents who did not write alone, 48% of the Japanese group and 47% of the U.S. group worked with the same group when producing written technical communications (Table 5). The average number of people in the Japanese group was $\overline{X} = 5.11$, and the average number of people in the U.S. group was $\overline{X} = 3.21$. Thirty-one percent of the Japanese respondents worked in an average (mean) number of 3.10 groups, each group containing an average of 3.14 people. Forty percent of the U.S. respondents worked in an average (mean) number of 2.82 groups, each group containing an average (mean) of 3.03 people.

Table 5. Production of Written Technical Communications as a Function of Number of Groups and Group Size for Japan and U.S. Aerospace Engineers and Scientists

	Japan		U.S.	
Groups and Group Size	%	(n)	%	(n)
Worked with same group				
Yes	48	(45)	47	(161)
No	31	(29)	38	(129)
I only write alone	21	(20)	15	(50)
	$\overline{X}$	(n)	$\overline{X}$	(n)
Number of people in group				
Mean	5.11	(45)	3.21*	(161)
Median	3.00	(45)	3.00	(161)
Number of groups				
Mean	3.10	(29)	2.82*	(129)
Median	3.00	(29)	3.00	(129)
Number of people in each group				
Mean	3.14	(29)	3.03	(129)
Median	3.00	(29)	3.00	(129)

*$p \leq .05$.

An Undergraduate Course in Technical Communications

Japanese and U.S. participants were asked their opinions regarding the desirability of undergraduate aerospace engineering and science students taking a course in technical communications. Approximately 72% of the Japanese respondents and 96% of the U.S. participants indicated that aerospace engineering and science students should take such a course. Approximately 44% of the Japanese participants and about 90% of the U.S. participants indicated that the course should be taken for credit (Table 6).

Table 6. Need for an Undergraduate Course in Technical Communications for Aerospace Engineering and Science Students

	Japan		U.S.	
Options	%	(n)	%	(n)
Taken for credit	44	(41)	90	(259)
Not taken for credit	15	(14)	4	(11)
Don't know	13	(12)	2	(6)
Should not have to take course in technical communications	28	(27)	4	(11)

The Japanese and U.S. participants who thought that undergraduate aerospace engineering and science students should take a course in technical communications were asked how the course should be offered. About 19% of the Japanese respondents indicated that the course should be taken as part of a "required" course, about 43% thought the course should be taken as part of an "elective" course, none thought it should be taken as a "separate" course, about 10% did not have an opinion, but only 28% of the Japanese respondents indicated that undergraduate aerospace engineering and science students should **not have to take** a course in technical communications/writing.

About 82% of the U.S. respondents indicated that the course should be taken as part of a "required" course, about 12% thought the course should be taken as part of an "elective" course, none thought it should be taken as a "separate" course, about 2% did not have an opinion, but only 4% of the U.S. respondents indicated that undergraduate aerospace engineering and science students should **not have to take** a course in technical communications/writing. A simple majority of the U.S. respondents (51%) indicated that the technical communications/writing instruction should be taken as a separate course, while only 21% of the Japanese respondents indicated that the technical communications/writing instruction should be taken as a separate course.

Use of Libraries

Almost all of the respondents indicated that their organization has a library. Unlike the U.S. participants (9%), about 43% of the Japanese respondents indicated that the library was located in the building where they worked. About 55% of the Japanese and 88% of the U.S. respondents indicated that the library was outside the building in which they worked but was located nearby. For 52% of the Japanese group, the library was located 1 kilometer or less from where they worked. For about 81% of the U.S. respondents, the library was located 1.0 mile or less from where they worked.

Respondents were asked to indicate the number of times they had visited their organization's library in the past 6 months (Table 7). Overall and statistically, the Japanese respondents used their organization's library more than their U.S. counterparts did. The average use rate for Japanese respondents was $\overline{X} = 20.9$ during the past 6 months compared to $\overline{X} = 9.2$ for the U.S. respondents. The median 6-month use rates for the two groups were 10.0 and 4.0, respectively.

Table 7. Use of the Organization's Library in Past 6 Months by Japanese and U.S. Aerospace Engineers and Scientists

	Japan		U.S.	
Number of Visits	%	(n)	%	(n)
0	12	(11)	11	(37)
1-5	16	(15)	43	(145)
6-10	29	(27)	21	(72)
11-25	19	(18)	14	(49)
26-50	16	(15)	7	(22)
51 or more	6	(6)	1	(4)
Does not have a library	2	(2)	3	(11)
Mean	20.9		9.2*	
Median	10.0		4.0	

*$p \leq .05$.

Respondents were also asked to rate the importance of their organization's library (Table 8). Importance was measured on a 5-point scale with 1 = not at all important and 5 = very important. A majority of both groups indicated that their organization's library was important to performing their present professional duties. About 73% of the Japanese aerospace engineers and scientists indicated that their organization's library was important or very important to performing their present professional duties. About 68% of the U.S. aerospace engineers and scientists indicated that their organization's library was important or very important to performing their present professional duties. Approximately 7% of the Japanese respondents and approximately 13% of the U.S. respondents indicated that their organization's library was very unimportant to performing their present professional duties.

Table 8. Importance of the Organization's Library to Japanese and U.S. Aerospace Engineers and Scientists

	Japan		U.S.	
Importance	%	(n)	%	(n)
Very important	73.4	(45)	68.2	(232)
Neither important nor unimportant	17.0	(40)	15.6	(53)
Very unimportant	7.4	(7)	12.9	(44)
Do not have a library	2.1	(2)	3.2	(11)
Mean	4.2		4.0	
Median	4.0		4.0	

<u>Use and Importance of Electronic (Computer) Networks</u>

Survey participants were asked if they use electronic (computer) networks at their workplace in performing their present duties. Approximately 55% of the Japanese respondents use electronic networks, and about 45% either do not use (30%) or do not have access to (15%) electronic networks (Table 9). About 89% of the U.S. respondents use electronic networks in performing their present duties and about 12% either do not use (9%) or do not have access to (3%) electronic networks. Statistically, U.S. respondents made greater use of electronic (computer) networks than did their Japanese counterparts.

Respondents were also asked to rate the importance of electronic networks in performing their present duties (Table 10). Importance was measured on a 5-point scale with 1 = not at all important and 5 = very important. Statistically, U.S. respondents rated electronic networks more important than did their Japanese counterparts. More Japanese (18.1%) than U.S. respondents (11.2%)

Table 9. Use of Electronic (Computer) Networks by Japanese and U.S. Aerospace Engineers and Scientists

	Japan		U.S.	
Percentage of a 40-hour Work Week	%	(n)	%	(n)
0	4	(4)	1	(4)
1-25	50	(47)	53	(180)
26-50	1	(1)	17	(57)
51-75	0	(0)	8	(26)
76-99	0	(0)	9	(30)
100	0	(0)	1	(5)
Do not use or have access to electronic networks	45	(42)	12	(38)
Mean	4.2		30.1*	
Median	1.5		20.0	

*$p \leq .05$.

Table 10. Importance of Electronic (Computer) Networks to Japanese and U.S. Aerospace Engineers and Scientists

	Japan		U.S.	
Importance	%	(n)	%	(n)
Very important	34.1	(32)	65.0	(221)
Neither important nor unimportant	18.1	(17)	11.2	(38)
Very unimportant	3.2	(3)	7.6	(43)
Do not use or have access to electronic networks	44.7	(42)	16.2	(38)
Mean	3.8		4.1*	

*$p \leq .05$.

indicated that electronic (computer) networks were neither important nor unimportant in performing their present professional duties.

Use of Foreign and Domestically Produced Technical Reports

To better understand the transborder migration of scientific and technical information (STI) via the technical report, survey participants were asked about their use of foreign and domestically produced technical reports (Table 11) and the importance of these reports in performing their professional duties (Table 12). Both groups make great use of their own technical reports (87% of the Japanese respondents use NAL reports and 97% of the U.S. group use NASA technical reports). In addition to their own reports, the Japanese respondents use NASA (89%); AGARD (60%); German DFVLR, DLR, and MBB (53%); and British ARC and RAE (48%) technical reports.

In addition to their own reports, the U.S. group uses AGARD (82%) and British ARC and RAE (54%) technical reports. Neither group makes great use of Indian NAL, Dutch NLR, ESA, or Russian TsAGI technical reports. Survey participants were also asked about their access to these technical report series. Overall, the U.S. group appears to have better access to foreign technical reports than do their Japanese counterparts. Both groups have about equal access to NASA technical reports.

Technical report importance was measured on a 5-point scale with 1 = not at all important and 5 = very important. Both groups were asked to rate the importance of selected foreign and domestic technical reports in performing their present professional duties. The average (mean) importance ratings are shown in Table 12. The Japanese respondents rated the importance of U.S. NASA reports ($\overline{X} = 4.46$), followed by NATO AGARD ($\overline{X} = 3.67$), and German DFVLR, DLR, and MBB reports ($\overline{X} = 3.15$). The U.S. group rated NASA reports most important ($\overline{X} = 4.26$), followed by NATO AGARD ($\overline{X} = 3.42$) and British ARC and RAE reports ($\overline{X} = 2.89$).

Table 11. Use of Foreign and Domestically Produced Technical Reports by Japanese and U.S. Aerospace Engineers and Scientists

	Japan		U.S.	
Country/Organization	%	(n)	%	(n)
NATO AGARD*	59.6	(56)	82.2	(236)
British ARC and RAE	47.9	(45)	54.0	(155)
ESA	24.5	(23)	5.9	(17)
Indian NAL	3.2	(3)	6.3	(18)
French ONERA	39.4	(37)	41.1	(118)
German DFVLR, DLR, and MBB	53.2	(50)	36.2	(104)
Japanese NAL	87.2	(82)	11.5	(33)
Russian TsAGI	2.1	(2)	8.4	(24)
Dutch NLR	23.4	(22)	19.9	(57)
U.S. NASA	89.4	(84)	96.5	(277)

*Advisory Group for Aerospace Research and Development.

Table 12. Importance of Foreign and Domestically Produced Technical Reports to Japanese and U.S. Aerospace Engineers and Scientists

	Japan		U.S.	
Country/ Organization	Rating[a] $\overline{X}$	(n)	Rating[a] $\overline{X}$	(n)
NATO AGARD	3.67	(85)	3.42	(282)
British ARC and RAE	3.12	(85)	2.89	(266)
ESA	2.78	(79)	1.44*	(242)
Indian NAL	2.02	(52)	1.40*	(241)
French ONERA	2.97	(79)	2.25*	(257)
German DFVLR, DLR, and MBB	3.15	(84)	2.20*	(247)
Japanese NAL	3.94	(93)	1.63*	(239)
Russian TsAGI	2.23	(43)	1.60*	(231)
Dutch NLR	2.65	(60)	1.81*	(246)
U.S. NASA	4.46	(92)	4.26	(285)

[a]A 5-point scale was used to measure importance with "1" being the lowest possible importance and "5" being the highest possible importance. Hence, the higher the average (mean) the greater the importance of the report series.

*$p \leq .05$.

Discussion

Given the limited purposes of this study, the overall response rates, and the research design, no claims are made regarding the extent to which the attributes of the respondents in the studies accurately reflect the attributes of the populations being studied. A much more rigorous research design and methodology and larger samples would be needed before any claims could be made. Nevertheless, the findings do permit the formulation of the following general statements regarding the technical communications practices of the Japanese and U.S. aerospace engineers and scientists who participated in this study.

1. The ability to communicate technical information effectively is important to Japanese and U.S. aerospace engineers and scientists.
2. The Japanese engineers and scientists possess greater language fluency (i.e., reading and speaking) than their U.S. counterparts.
3. Statistically, U.S. aerospace engineers and scientists spent more time (e.g., hours each week) communicating information, orally and in writing, to others than did their Japanese counterparts.
4. Statistically, U.S. aerospace engineers and scientists spent more time (e.g., hours each week) working with written information received from others and receiving information orally from others than did their Japanese counterparts.
5. More Japanese respondents write alone than did their U.S. counterparts. Of those Japanese respondents who write with others, the average number of persons per group, the average number of groups, and the average number of people in each group exceeded the number in each category for their U.S. counterparts.
6. Both Japanese and U.S. respondents indicated that aerospace engineering and science students should take a course in technical communications. Both groups of respondents indicated that the course should be taken for academic credit.
7. Statistically, Japanese aerospace engineers and scientists had used a library more times in the past 6 months than did their U.S. counterparts. Both groups of respondents reported that a library is important to performing their present professional duties.
8. Statistically, U.S. aerospace engineers and scientists made greater use of electronic (computer) networks in performing their professional duties than did their Japanese counterparts. Statistically, the U.S. aerospace engineers and scientists in this study rated electronic (computer) networks more important in performing their present professional duties than their Japanese counterparts rated them.
9. U.S. and Japanese respondents made the greatest use of NASA technical reports and rank them highest in terms of importance in performing their professional duties. Both groups make extensive use of (and consider important) NATO, AGARD technical reports.

Concluding Remarks

The 1980s witnessed an expansion of international commerce in terms of multinational production and joint manufacturing ventures. This is especially true in aerospace and the production of large commercial aircraft. This expansion has triggered interest in understanding the role of language and culture in the success of such ventures. Although a considerable body of knowledge about employee management practices has been developed, very little is known about how language and culture affect communication practices and information-seeking behaviors of engineers and scientists and how language and culture influence production, transfer, and use of scientific and technical information. Although the results of this study add to the knowledge base, they are more exploratory than conclusive and should be followed up with a larger study that will render results that are generalizable and can be used by managers and information developers and providers. A better understanding of and exposure to foreign language, culture, and business practices by Japanese and U.S. aerospace engineers and scientists can be an important step toward successful collaboration and may help create a "level playing field" for competition.

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